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Document 5

Severe Thunderstorms 17-18 Nov 2013

Note: Incorrect Date
Printed - Correct Date is
2012

Impacts for Aviation Services

1 Introduction

During the weekend 17 to 18 November 2012, five thunderstorm complexes passed over Brisbane Aerodrome. This report will be presented in 5 Events;

Event 1: Severe thunderstorm 170041UTC

Event 2: Squall line 171000UTC

Event 3: Rapid thunderstorm development 172200UTC

Event 4: Several squall lines 180000-180500UTC

Event 5: Rapid thunderstorm development ahead of squall line 180746UTC

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2 Event 1: Severe thunderstorm 170041UTC

Post analysis: The thunderstorm complex formed during a climatologically diurnal minimum period at around 161830UTC west of St George and tracked eastwards at between 30 and 35 knots, reaching Brisbane airport at 170041UTC. This large thunderstorm complex developed on the leading edge of a middle level cold pool. Figures 1-4 represent the sequence of events. As the storms moved east they showed signs of development on the northern flank. Between 23:06 UTC and 23:30 UTC, the scale of development on the northern edge increased rapidly possibly due to the presence of a subtle clear air wind change boundary interacting with the storm. Further rapid development occurred on the northern flank between 00:12UTC and 00:42UTC with a new thunderstorm updraft replacing the earlier storms.

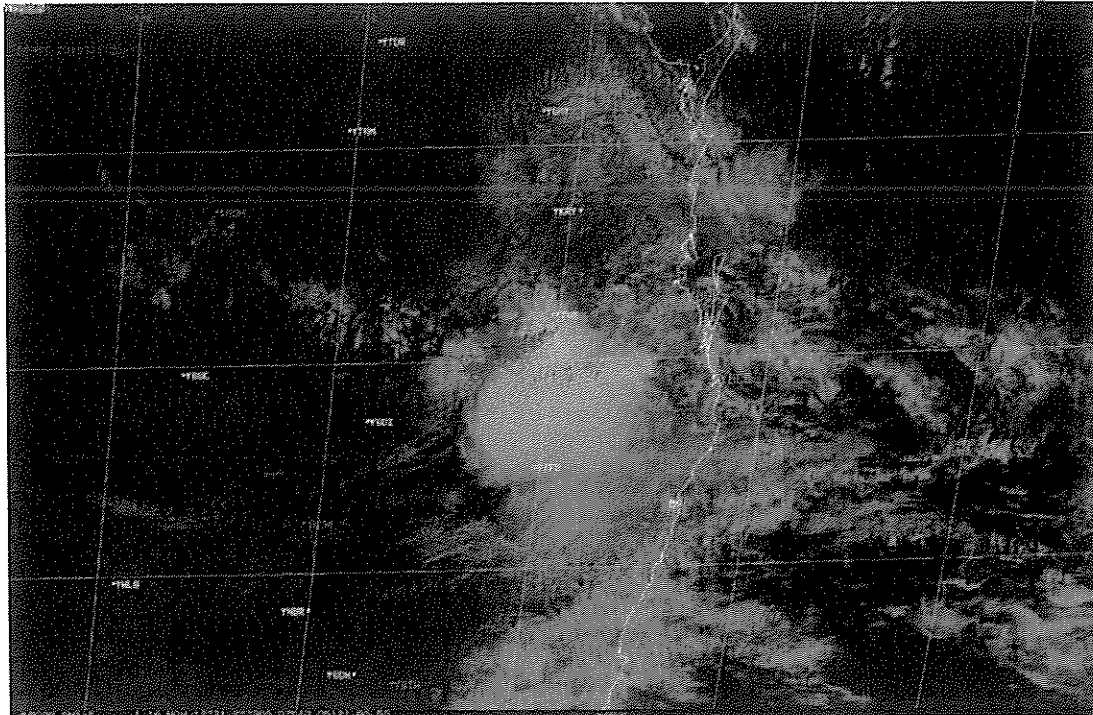


Figure 1: Visible satellite image with lightning strikes 162230UTC

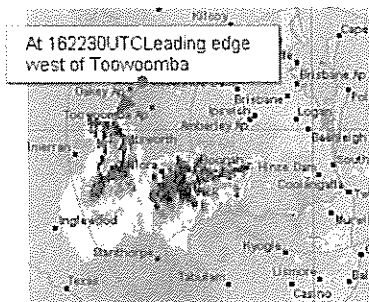


Figure 2: Radar 162230UTC

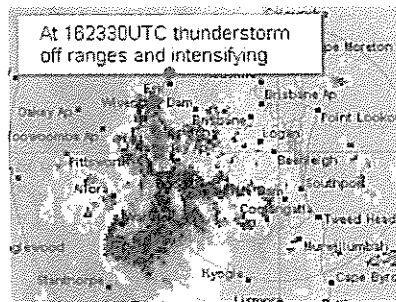


Figure 3: Radar 162330 UTC

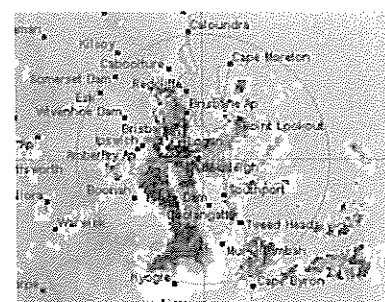


Figure 4: Radar 170048 UTC

The first indication of a thunderstorm on the Brisbane TTF was 41 minutes before the event when the storm was around 30nm to the WSW of YBBN



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TTF METAR YBBN 170000Z 14006KT 9999 FEW015 SCT110 BKN170 25/19 Q1012 RMK RF00.0/000.0
TEMPO 0000/0200 VRB25G35KT 2000 TSRA BKN010 SCT030CB

TTF METAR YBBN 170030Z 15006KT 9000 VCSH FEW015 SCT026 BKN085 26/20 Q1012 RMK RF00.0/000.0
TEMPO 0030/0200 VRB25G35KT 2000 TSRA BKN010 SCT030CB

TTF SPECI YBBN 170041Z 12006KT 9000 TS FEW015 SCT022 BKN085 FEW035CB 25/20 Q1012 RMK RF00.0/000.0
TEMPO 0043/0200 VRB25G35KT 2000 TSRA BKN010 SCT030CB

The Brisbane TAF gave a lead time of 47 minutes when the storm was 30-35nm to the WSW of YBBN. Thunderstorms were initially forecast from 170500UTC with the TAF being amended at 162354UTC to PROB30 thunderstorms from 170000UTC. The thunderstorms were still expected to dissipate as they moved into a more stable environment. The TAF was amended earlier at 23:40UTC to include reduced visibility in showers

TAF AMD YBBN 162340Z 1700/1806
08012KT 9999 -SHRA SCT025
FM171000 35006KT 9999 -RA SCT020 BKN050 BKN100
FM180000 32006KT 9999 -SHRA SCT020 SCT040
INTER 1700/1710 3000 SHRA BKN012
TEMPO 1710/1724 5000 RA BKN010
INTER 1800/1806 3000 SHRA BKN012
PROB30 TEMPO 1705/1806 VRB25G35KT 2000 TSRA BKN010 SCT030CB
RMK
T 25 27 27 25 Q 1012 1010 1009 1011

TAF AMD YBBN 162354Z 1700/1806
08012KT 9999 -SHRA SCT025
FM171000 35006KT 9999 -RA SCT020 BKN050 BKN100
FM180000 32006KT 9999 -SHRA SCT020 SCT040
INTER 1700/1710 3000 SHRA BKN012
TEMPO 1710/1724 5000 RA BKN010
INTER 1800/1806 3000 SHRA BKN012
PROB30 TEMPO 1700/1802 VRB25G35KT 2000 TSRA BKN010 SCT030CB
(Note: error COR issued changed to 1700/1702)
PROB30 TEMPO 1705/1806 VRB25G35KT 2000 TSRA BKN010 SCT030CB
RMK
T 25 27 27 25 Q 1012 1010 1009 1011

An Airport Warning was issued for Brisbane Airport at 23:55UTC, 46 minutes prior to the event.

YBBN AD WRNG 1 VALID 170000/170200Z
AERODROME WARNING NUMBER 1 FOR BRISBANE VALID 171000/171200 LOCAL
ISSUED 162355Z [170955 LOCAL]
THUNDERSTORMS ARE LIKELY TO AFFECT THE AERODROME WITHIN THE VALIDITY
PERIOD. THUNDERSTORMS MAY CONTAIN STRONG WINDS GUSTS OVER 41 KNOTS
AND VERY HEAVY RAIN.



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The duty night shift senior forecaster wrote in the Forecast Policy issued at 2:41 am EST on Saturday 17 November 2012:

"Surface trough near stationary on SE coast, becoming a convergence line and curves back into the Darling Downs to the SW. This trough then merges with western trough over the Darling Downs as a "V". Maximum instability over the SE region with the convergence and heating will lead to early thunderstorm build up and will increase into the afternoon with possible severe cells."

This indicates that the Brisbane RFC was anticipating early thunderstorm build up in parts of the south-east Queensland region with possible severe cells developing as additional heating took place.

The day shift duty aviation forecaster responsible for Brisbane aerodrome TAF YBBN and TTF YBBN and the duty senior forecaster were aware of the thunderstorm complex on radar and satellite pictures. In the absence of the low level routine temperature and sounding information, forecasters reverted to the use of other sources of data to analyse the environment. Combining surface temperature and dewpoint conditions and the modelled upper atmosphere, forecasters felt that the storms were not sourcing surface air. Available computer modelling indicated that the atmosphere near Brisbane was fairly stable and that heating would further destabilise the environment increasing the likelihood of thunderstorms later in the day. Between 162200 and 170000 the aviation forecaster reported he was closely tracking the thunderstorm complex and held regular conversations with the senior forecaster. The senior forecaster was working under the premise that the thunderstorm complex would weaken after moving away from the ranges. When it became clear that the complex had not weakened and in fact had developed on the northern flank making it more likely to impact YBBN, amendments were issued. The fast movement of the thunderstorm complex was a factor in the short lead time as was the two phases of new development on the northern flank.

The TAF amendment was issued 47 minutes prior to the event, the airport warning 46 minutes and the TTF gave a 41 minute lead time before thunderstorms affected Brisbane aerodrome.

Some of the reasons for this short advice were:

1. The absence of scheduled temperature and stability soundings at 161100 and 162300UTC owing to failure of a computer card in the sounding equipment. This meant that judgement regarding the type of atmosphere the thunderstorms were moving into was made more difficult. Humidity sensors on aircraft would make AMDAR data even more useful in similar events.
2. Fast movement of the complex thunderstorm 30 to 35 knots. The assumption by the senior forecaster was that the modelled atmosphere was more stable nearer the airport and the system would weaken.
3. The two phases of rapid development on the northern flank of the storm meaning the northern-most portion of the complex extended to Brisbane Airport.
4. Thunderstorm occurred at a climatological minimum, which is extremely rare.
5. The strength of the storm at the surface may have been enhanced by large amounts of hail melting in the upper atmosphere adding momentum to the downdraft.



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3 Event 2: Squall line 171000UTC

Post analysis: This event had its origins well west of Brisbane Airport when thunderstorms formed near Roma at about 170400UTC. A large supercell thunderstorm formed SW of Oakey just after 06:00UTC and moved north producing very damaging hailstones. As this large storm decayed a line of thunderstorms tracked steadily eastwards reaching Brisbane aerodrome at 171000UTC. Figures 5-7 show the steady progression and intensification of the squall line as it approached Brisbane aerodrome.

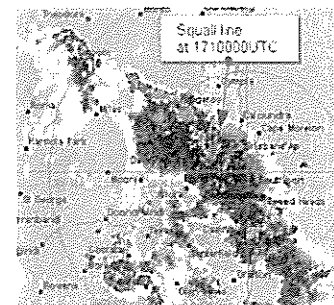
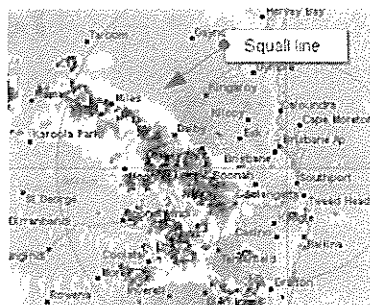
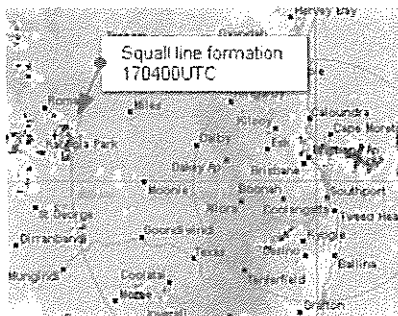


Figure 5: Radar image 170400UTC

Figure 6: Radar image at 170700UTC

Figure 7: Radar Image at 171000UTC

Following the morning thunderstorm and original policy of afternoon severe thunderstorm formation the Brisbane TAF covered this squall line event.

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TAF AMD YBBN 170527Z 1706/1812
03010KT 9999 -SHRA SCT025
FM171000 35005KT 9999 -RA SCT020 BKN050 BKN100
FM180000 32007KT 9999 -SHRA SCT020 SCT040
FM181000 17009KT 9999 -SHRA SCT020 SCT030
TEMPO 1710/1724 5000 RA BKN010
INTER 1808/1812 3000 SHRA BKN012
PROB30 TEMPO 1707/1808 VRB25G35KT 2000 TSRA BKN010 SCT030CB
RMK
T 26 25 23 22 Q 1010 1009 1010 1011
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TAF AMD YBBN 170825Z 1708/1812
07008KT 9999 -SHRA SCT020
FM171000 35005KT 9999 -RA SCT020 BKN050 BKN100
FM180000 32007KT 9999 -SHRA SCT020 SCT040
FM180900 17009KT 9999 -SHRA SCT020 SCT030
INTER 1808/1812 3000 SHRA BKN012
TEMPO 1708/1809 VRB25G35KT 2000 TSRA BKN010 SCT030CB
RMK
T 24 22 21 21 Q 1010 1011 1009 1009
```

Forecasters report that there was some debate as to the necessity of the TAF AMD issued at 170825UTC. This TAF amend removed mention of rain and reduced visibility (TEMPO 1710/1724 5000 RA BKN010) and changed the forecast of thunderstorm to remove the PROB 30 and extended the period to 1708/1809.



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The TTF forecast thunderstorms at YBBN at 170800 giving 2 hours lead time at a time when the largest cell was moving NNE. There was a technical fault with the issue of the 170830UTC TTF YBBN.

TTF METAR YBBN 170800Z 09005KT 9999 FEW014 BKN018 BKN035 24/20 Q1010 RMK RF00.0/018.4 TEMPO 1000/1100 VRB25G35KT 2000 TSRA BKN010 SCT030CB

TTF METAR YBBN 170830Z 09004KT 9999 VCSH FEW014 SCT023 BKN040 24/21 Q1009 RMK RF00.0/018.4

TTF METAR YBBN 170900Z 06005KT 9999 VCSH SCT014 SCT030 BKN050 FEW025CB 24/21 Q1010 RMK RF00.0/018.4 CB'S TO W

TEMPO 1000/1100 VRB25G35KT 2000 TSRA BKN010 SCT030CB

TTF METAR YBBN 170930Z 09004KT 9999 VCSH SCT014 BKN035 FEW025CB 24/21 Q1010 RMK RF00.0/018.4 CB'S TO W

TEMPO 1000/1230 VRB25G35KT 2000 TSRA BKN010 SCT030CB

TTF METAR YBBN 171000Z 10005KT 9999 -SHRA FEW014 BKN020 FEW025CB 24/22 Q1011 RMK RF00.0/018.4 CB'S TO W

TEMPO 1000/1300 VRB25G35KT 2000 TSRA BKN010 SCT030CB

An aerodrome warning for Brisbane was issued at 170843UTC

YBBN AD WRNG 1 VALID 170840/171400Z

AERODROME WARNING NUMBER 1 FOR BRISBANE VALID 171840/180000 LOCAL

ISSUED 170843Z [171843 LOCAL]

THUNDERSTORMS ARE LIKELY TO AFFECT THE AERODROME WITHIN THE VALIDITY PERIOD. THUNDERSTORMS MAY CONTAIN STRONG WINDS GUSTS OVER 41 KNOTS. LARGE HAIL AND VERY HEAVY RAIN.

Given the morning thunderstorm demonstrated that the atmosphere about Brisbane was unstable and capable of producing severe thunderstorms, forecasting this squall line was a matter of correctly tracking movement. The duty forecaster correctly forecast the clearance at 171400UTC on the TTF issued at 171130.

TTF SPECI YBBN 171130Z 08003KT 7000 TSRA FEW018 BKN030CB 23/22 Q1012 RETS RMK RF00.4/021.6 FM1130 09007KT 9999 -RA FEW010 SCT025 BKN040 TEMPO 1130/1400 VRB25G35KT 2000 TSRA BKN010 SCT030CB TEMPO 1400/1430 3000 SHRA BKN010

The clearance SPECI was issued at 171400UTC

TTF SPECI YBBN 171400Z 30005KT 9999 -RA FEW005 BKN110 19/18 Q1011 RETS RMK RF00.0/054.6 TEMPO 1400/1700 3000 SHRA BKN010

There were no apparent forecast deficiencies in relation to this thunderstorm. The two hour lead time on the TTF seemed prudent given that the TAF had PROB30 TEMPO for thunderstorms and the forecaster was using the TTF for refining the timing of this event.



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4 Event 3: Rapid thunderstorm development 172200UTC

Post analysis: An area of rain with embedded thunderstorms was located north of Brisbane over the Sunshine Coast. It appears that outflow from this rain/thunderstorm cluster initiated lines of showers NW of Brisbane aerodrome. These lines of showers then rapidly formed into several lines of thunderstorms. During the morning lines of thunderstorms moved over Brisbane aerodrome. Figures 8 to 11 show the extent of the rainfall.

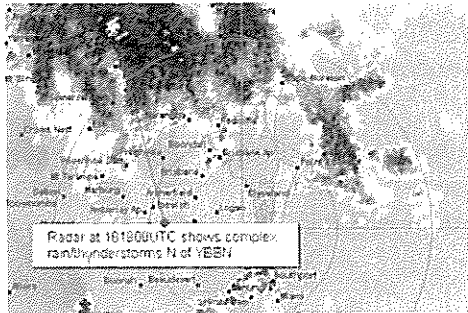


Figure 8: Radar image at 181900

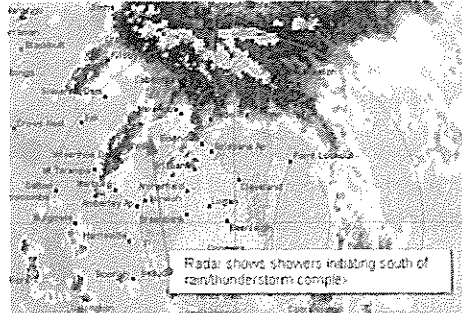


Figure 9: Radar image at 182030

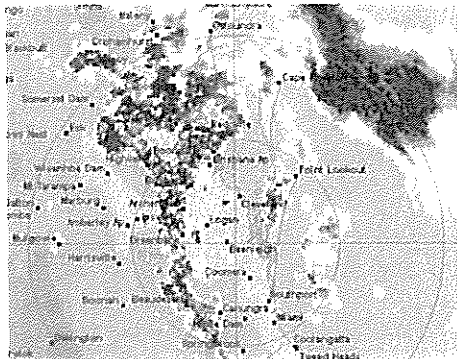


Figure 10: Radar image at 172200



Figure 11: Radar image at 180024UTC

The forecast policy expected more thunderstorms to form, some severe. The TAF summary indicated the forecaster thought that 180100 to 180500 was the most likely formation time based on the passage of a trough.

FORECAST POLICY FOR QUEENSLAND

Issued at 2:30am AEST on Sunday the 18th of November 2012

TODAY: A surface trough stretches from NW QLD to the SE interior, and down to a low over NSW. A moist low level jet ahead of the trough is currently producing TS over the Downs. Converging W/NW lies ahead of the trough a bit above the surface [e.g. at 5000ft] will work with an upper trough over eastern QLD to produce more strong storms over the SE [possibly severe].



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BRISBANE AIRPORT WEATHER BRIEFING

Issued at 1745Z on the 17/11/2012 [0345 on the 18/11/2012 LOCAL]

TAF SUMMARY

A mid to upper trough is expected to pass through Brisbane tonight. Showers and thunderstorms are expected before the arrival of the trough and maybe one or two showers soon afterwards. The most likely time for thunderstorms appears to be between 01Z and 05Z, due to a low level feature passing through around that time and a drying of the mid to upper levels afterwards.

The briefing also mentioned of a 10% possibility of thunderstorm occurring before 00Z

Thunderstorms were forecast on TAF YBBN from 1800/1809 UTC. Reduced visibility in rain showers for periods 30 to 60minutes was forecast between 1718 and 1724.

Heavy convective weather was forecast for the morning period but without the strong heating of the day, it was deemed to be unlikely that the showers would reach sufficient depth to produce lightning. Reanalysis of 3-dimension radar data suggests cloud tops below that required to produce lightning until the period just prior to the first report.

TAF YBBN 171733Z 1718/1824
VRB07KT 9999 -SHRA FEW015 SCT025 BKN040
FM180000 36010KT 9999 -SHRA SCT020 SCT040
FM181200 20007KT 9999 SCT010 SCT025
TEMPO 1718/1724 3000 SHRA BKN010
INTER 1800/1810 3000 SHRA BKN012
PROB40 TEMPO 1800/1809 VRB25G35KT 2000 TSRA BKN010 SCT030CB
RMK
T 20 23 26 26 Q 1008 1009 1009 1007

TAF AMD YBBN 172300Z 1800/1906
34010KT 9999 -SHRA SCT020 SCT040
FM181200 20007KT 9999 SCT010 SCT025
FM190000 02014KT 9999 SCT030
INTER 1800/1809 3000 SHRA BKN012
TEMPO 1814/1821 BKN010
PROB40 TEMPO 1800/1809 VRB25G35KT 2000 TSRA BKN010 SCT030CB
RMK
T 23 26 26 24 Q 1010 1007 1006 1007

TTF was forecasting TEMPO then INTER for visibility reductions in showers.

TTF METAR YBBN 172130Z 00000KT 9999 -RA FEW001 SCT015 BKN110 20/19 Q1010 RMK RF00.0/055.2
TEMPO 1700/2330 3000 SHRA BKN010
INTER 2330/0030 3000 SHRA BKN010

As soon as thunder was heard at Brisbane airport the TTF was updated. The forecast assumption based on nowcast evidence was for a period of showers prior to thunderstorm development. There was little lead time to forecast these thunderstorms on TTF YBBN, though TEMPO conditions for vis 3000 were existing

TTF METAR YBBN 172200Z 35008KT 9999 VCTS VCSH FEW001 SCT014 BKN100 FEW045CB 21/19 Q1010 RMK
RF00.0/055.2
FM2200 35008KT 9999 -SHRA SCT012 BKN025
TEMPO 2200/2330 VRB15G35KT 2000 TSRA BKN010 SCT030CB
INTER 2330/0100 3000 SHRA BKN010



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Holding conditions for convective showers in the developing squall line were on the forecast. Some of these showers had sufficient depth to produce lightning. Forecasts indicated a later onset of thunderstorm activity but correctly forecast the shower activity. The procedures for amending the forecasts were carried out correctly.

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5 Event 4: Several squall lines 180000-180500UTC

Post analysis: Following the Sunday morning thunderstorms radar showed thunderstorm forming inland near Marburg at 180100UTC just as the last of the morning thunderstorms were clearing Brisbane Aerodrome. By 180230UTC a cluster of thunderstorm cells had formed west of Brisbane aerodrome tracking east wards. Radar showed many thunderstorm cells forming into squall lines tracking towards Brisbane aerodrome. The strongest thunderstorms passed just north of the aerodrome and the second wave of thunderstorms further south weakened as they approach Brisbane aerodrome. This is a classic example of at times seemingly random movement and weakening of thunderstorm cell as they approach a forecast location. Figures 12-16 are annotated radar displays at this time.

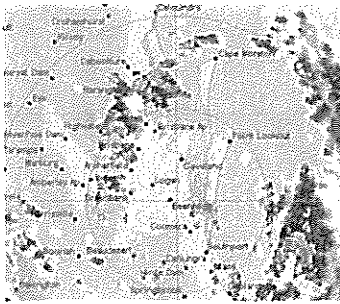


Figure 12: Radar image at 180024UTC

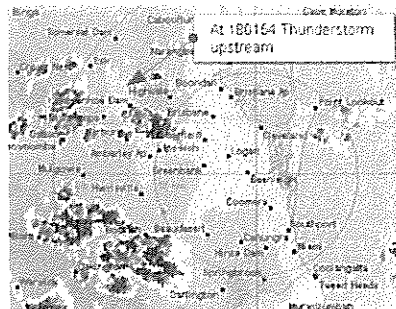


Figure 13: Radar image at 180154UTC

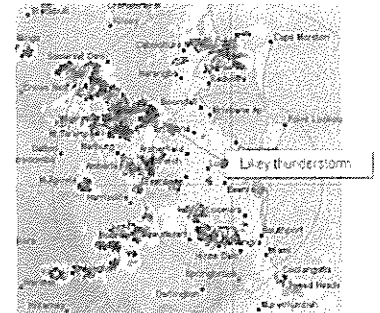


Figure 14: Radar image at 180254UTC



Figure 15: Radar Image at 180354UTC

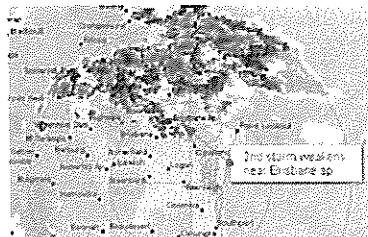


Figure 16: Radar image at 180418UTC

The forecast policy statement:

"FORECAST POLICY FOR QUEENSLAND

Issued at 10:15am EST on Sunday the 18th of November 2012

AM UPDATE: Upper trough moving through southern Qld has a double structure, with leading shortwave associated with this morning's convection moving offshore, and the trailing impulse arriving in phase with maximum heating during the day. Deep layer shear is maximised about the Wide Bay today under the mid level jet, however outflow from previous convection is providing N'ly flow over the SE coast, which will lead to a move favourable wind structure and stronger shear to go with moderate to strong instability this afternoon. Potential is in place for a few supercells, and given steep lapse rates, these would be capable of very large hail and destructive winds."

This policy statement indicates a good understanding of the forecast situation and that thunderstorms were expected at Brisbane airport.

Both the TAF and TTF for Brisbane aerodrome forecast thunderstorms from 180000 to 180900. TTF for YBBN forecast TEMPO Thunderstorms from 0300, with a lead time of 2 hours. Despite the large extent of thunderstorm lines west of Brisbane, these thunderstorms either drifted north or weakened as they approached the aerodrome. In a strict sense



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these forecasts were deficient in that they forecast thunderstorms that did not reach the airport. The forecast was correct based on the available information prior to the event.

TAF AMD YBBN 172300Z 1800/1906
34010KT 9999 -SHRA SCT020 SCT040
FM181200 20007KT 9999 SCT010 SCT025
FM190000 02014KT 9999 SCT030
INTER 1800/1809 3000 SHRA BKN012
TEMPO 1814/1821 BKN010
PROB40 TEMPO 1800/1809 VRB25G35KT 2000 TSRA BKN010 SCT030CB
RMK
T 23 26 26 24 Q 1010 1007 1006 1007

TTF SPECI YBBN 180053Z 21006KT 5000 TSRA SHRA FEW003 SCT042CB BKN075 21/19 Q1011 RETS RSHRA
RMK RF00.8/000.8
FM0100 24010KT 9999 -SHRA SCT020 SCT040
TEMPO 0053/0130 VRB20G35KT 2000 TSRA BKN010 SCT040CB
INTER 0130/0300 3000 SHRA BKN010
TEMPO 0300/0353 VRB20G35KT 2000 TSRA BKN010 SCT040CB

There were no deficiencies in the forecasts. Two thunderstorm cells were near misses but the percentage probability of a hit was high. These thunderstorms also looked strong and well developed on radar west of the aerodrome in the threat area but did not reach the aerodrome. The thunderstorms in this case either weakened or drifted north because the upper trough moved westward and the steering flow (winds in middle levels of the atmosphere that steer thunderstorms) gradually changed from westerly to more SW. Forecasters were anticipating this change, although the timing of the change and the affect on thunderstorms was difficult to forecast with good geospatial accuracy.

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6 Event 5: Rapid thunderstorm development ahead of a supercell 180746UTC

Post analysis: Radar loops show that the upper trough had passed through Brisbane around 180500UTC. This is illustrated by thunderstorm motion generally from the WSW. A cell SW of Boonah at 180512UTC (Figure 18) developed into a supercell and moved towards the NE (SW steering winds) and Brisbane aerodrome. By 180730UTC the thunderstorm squall line had made steady progress to reach Archerfield (Figure 19). The next radar scan 6 minutes later Figure 20 showed what appeared to be a new cell developing quickly well ahead of the main squall line. The next scan Figure 21, another 6 minutes later, showed this rogue cell had formed into a thunderstorm well ahead of the main squall line. So within 12 minutes the forecasters timing of the supercell approach to the west of YBBN was no longer valid and quick amendments were required. The new cell and the supercell interacted and the resultant thunderstorm complex affected the airport.

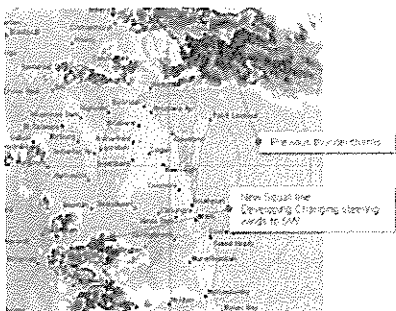


Figure 18: 180512UTC Squall line forming 3 hours prior to reaching Brisbane aerodrome

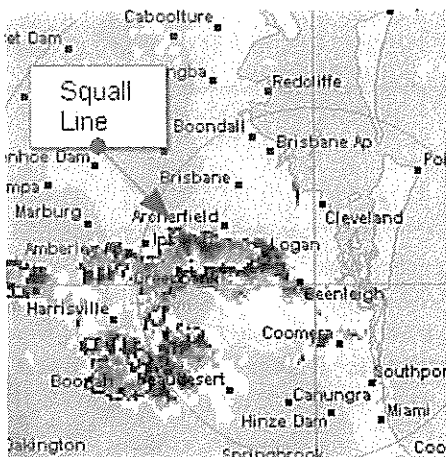


Figure 19: 180730UTC squall line

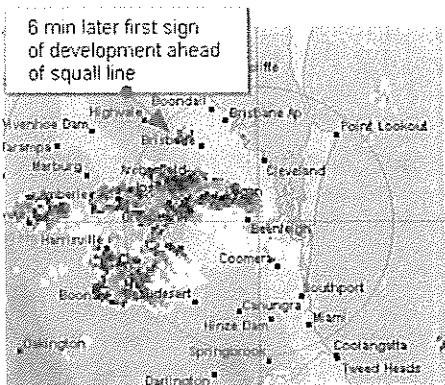


Figure 20: 180736UTC Initiation ahead of main squall line

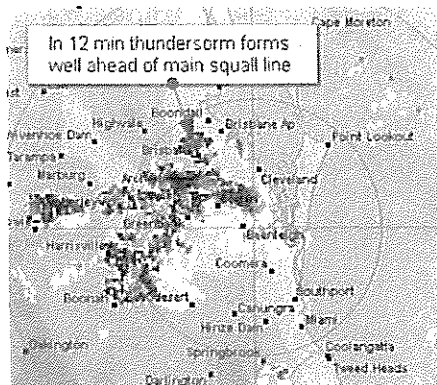


Figure 21: Rapid development of thunderstorm



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Forecasters were aware of the change in steering direction, however they were not sure of the exact track or the significant development ahead of the main thunderstorm squall line. The TAF had forecast PROB 30 thunderstorms, although the TTF represented the track of the main line which was expected to miss the airport.

TAF AMD YBBN 180507Z 1806/1912
VRB07KT 9999 -SHRA SCT020 SCT040
FM181200 20007KT 9999 SCT010 SCT025
FM190000 02014KT 9999 SCT030
FM190800 15014KT 9999 SCT025 BKN045
INTER 1806/1809 3000 SHRA BKN012
TEMPO 1814/1821 BKN010
PROB30 TEMPO1806/1809VRB25G35KT 2000 TSRA BKN010 SCT030CB
PROB30 1817/1821 0800 FG
RMK
T 24 24 22 21 Q 1007 1008 1009 1008

TTF METAR YBBN 180700Z 01013KT 9999 FEW012 SCT280 23/19 Q1007 RMK RF00.0/002.6
FM0700 03013KT 9999 SCT012

TTF METAR YBBN 180730Z 36010KT 9999 FEW012 SCT160 FEW040CB 22/18 Q1008 RMK RF00.0/002.6
FM0730 03013KT 9999 SCT012
INTER 0800/0900 VRB20G40KT 2000 TSRA BKN010 SCT040CB

TTF SPECI YBBN 180746Z 36011KT 9999 TSRA VCSH FEW010 SCT035CB BKN100 22/18 Q1007 RMK
RF00.0/002.6
FM0746 03013KT 9999 -SHRA SCT012 BKN020
TEMPO 0746/0900 VRB20G40KT 2000 TSRA BKN010 SCT035CB

TTF SPECI YBBN 180800Z 36012KT 4000 TSRA SHRA FEW008 SCT035CB BKN100 22/18 Q1008 RMK
RF00.0/002.6
FM0800 03013KT 9999 -SHRA SCT012 BKN020
TEMPO 0800/0900 VRB20G40KT 2000 TSRA BKN010 SCT035CB

The TAF had forecast PROB 30 thunderstorms and the TTF reflected a refined solution that was expected to miss the airport. The rapid development of the cell was not anticipated but procedures to correct forecasts were correctly carried out.